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THE PHILOSOPHY OF SPECIES-MAKING.¹

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1. THE SPECIES-CONCEPTION.—It is probable that the forms of life have sprung from one common or original point. At all events, there seems to be a general series of convergent histories in organic nature, when one attempts to trace genealogies. These multitudes of forms seem to bear some definite and intimate relation to the circumstances under which they live and grow; in fact, they appear to have resulted from the splitting up and modification of the original plasma by means of the contest of numbers and the changes and diversifications in the physical characters of the earth. There are as many forms or kinds of life as there are diverse and disputed places upon the earth, and the forms no doubt are still, for the most part, slowly adjusting themselves to the continuing changes in the conditions in which they grow. We now have the best of reasons for believing that the organic creation is a plastic one, and that it will continue to be modified so long as it is possible for life to exist upon the globe. If the forms of life shall finally perish, the extinction will be preceded by a long process of diminution of virility coming as an adjustment to increasingly untoward conditions.

When *men* first began the serious study of the forms of life, they were still convinced that the creation is a congeries of objects which had come directly from the hand of the Creator, a collection or a patchwork of most curious things. The intellectual grasp of the creation was not yet comprehensive enough to suggest, to many minds at least, that the universe is one thing, one conception, a unity in method; the mind therefore rested upon the individual objects and logically exalted them into the sphere of units in the creation. In other words, the ultimate units, the entities, in organic nature were, to the early

¹ Read by title before The Botanical Society of America, August 1896.

naturalists, the things which were to be seen. If the forms of life were the entities, then the units must have one common designation; and the technical expression applied to them was the word *species*. To make names and descriptions for these units was really to know nature; so there arose a desire to make inventories of nature, and the organic creation was speedily cut up into coordinate units. All this resulted in a species of versification or paragraphing of nature; and it would not be unfair to say that, in this conception, the species is the organic paragraph.

The reader will now perceive that the two attitudes of mind which are sketched in these two paragraphs are antagonistic and incompatible. If one is true, the other is necessarily untrue. Evolution, as a method, is either true or it is not true. It cannot be half true. If evolution is true, then the forms of life are not the units or entities in the organic creation; they are the disjointed remaining results of the world-long process of elimination, the incidental outcomes of a vicarious history. In some lines of ascent, notably in the mammals, these forms are, to be sure, exceedingly well marked, but these only attest the more strongly to the survival of the most specialized types. In other words, there are no species as understood by Ray and Linnæus and Cuvier and the older naturalists.

It is unnecessary to argue for the truth of evolution before this constituency; although I suspect that there are still botanists who accept evolution as true only in those particular groups in which they can observe some direct evidences of it, without seeing that such limitation of its action is a denial of its universality and therefore of its truth as a principle. Yet I suppose that I should not meet strong opposition if I say that naturalists now regard species as the final, that is, the present, adjustment of forms of life to circumstances; and yet the greater number of naturalists seem still practically to look upon the species as the organic unit. Even the definitions in our latest and best lexicons insist upon the intrinsic merits of species. The *Century Dictionary* defines a species, in biology, to be "that which is

specialized or differentiated recognizably from anything else of the same genus, family, or order ; an individual which differs, or collectively those individuals which differ, specifically from all the other members of the genus, etc., and which do not differ from one another in size, shape, color, and so on, beyond the limits of (actual or assumed) individual variability, as those animals and plants which stand in the direct relation of parent and offspring, and perpetuate certain inherited characters intact or with that little modification which is due to conditions and environment." The *Standard Dictionary* defines a species as "a classificatory group of animals or plants subordinate to a genus, and having members that differ among themselves only in minor details of proportion and color, and are capable of fertile interbreeding indefinitely." *Webster* is as follows: "In science, a more or less permanent group of existing things or beings, associated according to attributes, or properties determined by scientific observation." Stormonth's *English Dictionary* says that a species is "a group of individuals or objects sufficiently identical in all their natural qualities to justify the conclusion that they may have sprung from a common stock."

In all these definitions the idea of genetic continuity seems to be fundamental, and in this respect they are not greatly unlike the definitions which were current in pre-Darwinian times. They all seem to be descendants of Cuvier's conception that a species is "the reunion of individuals descended from one another, or from common parents, or from such as resemble them as closely as they resemble each other." This really amounts to little more than Linnæus' phrase, "We reckon as many species as there were forms created in the beginning."

Although we are driven to abandon the conception that the immediate forms of life are the units in the organic creation, we must nevertheless arrive at our knowledge of this creation by means of these forms. It is these forms which we take hold of when we study nature. They are the tangible objects with which we deal. Then they should be described and named ; but the important point is that the forms of life serve as a convenient

means of classifying our knowledge of nature, and are not entities in themselves. Species are, therefore, a human contrivance, and the only value which the modern naturalist can attach to them, as such, is their temporary convenience as a means and vehicle of thinking and writing about the organic creation. They should be defined only in terms of classification, not in terms of structure and genealogy, that is, in terms extrinsic, not terms intrinsic. Modern naturalists have largely eliminated genealogy from the definitions of species, but I do not recall any who define it solely as a convenience of taxonomy. Huxley writes that "a species is the smallest group to which distinctive and invariable characters can be assigned." Haeckel's definition is one of the very best but is too indefinite to be workable. In his conception the word species "serves as the common designation of all individual animals or plants which are equal in all essential matters of form, and are only distinguished by quite subordinate characters." Unsatisfied with the current definitions, I defined species, in *Survival of the Unlike*, as "a term used to classify animals and plants, by designating or grouping together all those forms or individuals which are very much alike in taxonomic marks." But this is too indefinite to be of much use. As I now conceive of it, I should define a species as follows: *The unit in classification, designating an assemblage of organisms which, in the judgment of any writer, is so marked and so homogeneous that it can be conveniently spoken of as one thing.*

II. THE ART OF SPECIES-MAKING.—When we come to the practical application and use of the word species, we must admit that the more carefully we distinguish the forms of life, the smaller or narrower must be the assemblages to which, for reasons of perspicuity, we apply the word. The smaller the classificatory divisions, the more exactly can we speak of organic life. We elucidate our subject more by dividing it than we do by massing it. I therefore look with favor upon the tendency in some quarters to make specific names for forms which have heretofore been regarded as well marked varieties, although I

admit that it is easy to acquire the tendency to give specific names to forms which are of such small taxonomic importance that the student may be confused rather than enlightened by the subdivision. The remarks in this paragraph represent Asa Gray's later conviction, a position which he once summed up to me, with his characteristic forcefulness, in the remark that "species are judgments." I remember his saying to me, in effect, that he should consider the Atlantic Ocean to be a good distinguishing mark between certain species; that is, that forms which would scarcely be considered to be specifically distinct when occupying the same or coterminous areas might properly be called species if they were separated distinctly by great natural barriers. I am quite sure that he looked upon very similar forms in very unlike geographical regions as tending towards greater differentiation, and whenever it was possible, in perspicuous treatment, to draw fairly good characters of separation between them he thought that it was expedient to do so. In other words, Gray would not make quantitative characters supreme in his designation of species.

I would not for a moment make it a test of a species that there should be no intergradient forms. If the intermediate forms are so few that they do not seriously obscure the mental conception of the type, then all interests will be subserved by disregarding them for purposes of nomenclature. In fact, I should expect very few species of plants to be perfectly free from aberrant and entangling forms. The groups of plants are rare in which one can say that the types are unique. Soil, exposure, climate, contest with fellows, and a hundred incidental circumstances leave their impress upon the plant forms.²

If the making of species is an expediency, then it follows that it is not necessary, or even desirable, that we should search for obscure or anatomical characters with which to separate them. These characters belong to anatomy, physiology, embry-

² It would seem that some exception might be made to these remarks in the lucid genus *Carex*, for Britton, in describing a new species, was able to find "crucial proof of its distinctness." Bull. Torr. Bot. Club 22:220.

ology, and the like, not to taxonomy. At all events, it seems to be clear that the species-division will be useful in proportion as it is founded upon obvious and easily ascertained attributes.

My own convictions respecting the art of species-making may be illustrated by a concrete example, which I have elsewhere published.³

"If this position is well taken, it follows that the naturalist should not describe new species with the idea of adding another item or organism to the inventory of nature, but for the purpose of classifying and clarifying our knowledge of the kind and extent of variation which the given group presents. A new species, therefore, is made simply for convenience's sake. In very variable groups it is perfectly justifiable to make species when it is known that occasional forms are intermediates, if thereby we are enabled to understand the relationships of the various forms more clearly. This is particularly true in narrow groups which have many forms of varying taxonomic importance. An illustration may be taken from the genus *Carex*. The *echinata* group contains four more or less coordinate main types, the *echinata* proper of the Old World, and three types in the United States. It has been the fashion to throw these all together into a composite species, calling it *Carex echinata*. In this arrangement, the subgroups or sub-forms do not stand out clearly, and it is impossible to contrast them forcibly. Moreover, the characters which separate the most marked sub-forms are of as great or even greater classificatory importance than characters which are used to separate *Carex echinata* itself from its fellow species. The old arrangement might be graphically presented as follows :

"*Carex echinata*.

Group B.

Subgroup *a*.

Subgroup *b*.

Subgroup *c*.

Group C.

Group D.

Subgroup *a*.

"This classification, from a taxonomic standpoint, is untrue, for, as *Carex* species go, groups B, C, D are coordinate with *C. echinata*, and not subordinate to it. The mere fact that there are now and then intermediate forms between these various groups should not deprive us of the privilege of expressing the taxonomic facts. In nearly every instance specimens can be clearly referred to one or the other of the groups by one who is familiar with

³ Survival of the Unlike, 134, 135.

them ; but so long as the various groups are represented to be of minor and variable importance—as the above arrangement does represent them to be, to a botanist's mind—so long will they remain to be comparatively little distinguished and understood. Consequently I have erected (Bull. Torr. Bot. Club 20:422) the four groups into coordinate species, as follows :

A. *Carex echinata*. Old World.

B. *Carex sterilis*. New World.

a. var. *excelsior*.

b. var. *cephalantha*.

c. var. *angustata*.

C. *Carex Atlantica*.

D. *Carex interior*.

a. var. *capillacea*."

III. THE HYBRIDITY COROLLARY.—Intermediate forms are the most confusing and disturbing elements in species-divisions. These forms may be (*a*) normal intergradients, (*b*) unusual or sportive aberrations, or (*c*) hybrids. The marks of hybrids are generally inconstant and evasive, and yet it is of the utmost importance to perspicuous taxonomy that one shall be able to determine hybrids from normal variations. There are certain general evidences of hybridity which the student may apply with very satisfactory results to intermediates of which he suspects a hybrid origin. I have been in the habit of giving seven categories of tests to my students. These have been suggested mostly by a study of known hybrids in domestic plants. The student must be cautioned that the satisfying of any one of these tests is not a proof of hybrid origin, but if the suspected forms answer more or less closely to three or more of them hybridity generally may be inferred with some confidence. These tests are as follows :

A. *Evidences of variation*.

1. Intermediateness of characters between any two species is an evidence of hybrid origin, and this evidence is the greater the more unvariable the suspected parents normally are.

2. Variation or gradation towards one or two related species arouses a very strong suspicion of hybrid origin, and the evi-

dence is the stronger the more numerous the variant individuals are.

3. Monstrous, sportive, and scattering variations are often evidences of hybridity. These evidences are especially significant when they pertain to the inflorescence, or to the essential organs of the flower.

4. Seedlessness, or greatly reduced seed-bearing, is very good evidence of hybridity in cases where related species are fructiferous.

B. *Evidences of distribution.*

5. Intimate association of the suspected forms with species which appear to be their parents is one of the strongest proofs of hybrid origin. It is not essential, as evidence, that the suspected forms grow actually amongst or with the supposed parents, for hybrids often occur at a distance of several rods, and sometimes even a mile or more, from their parents. It often happens, too, that one of the parents will disappear from the neighborhood before the hybrids do. In some instances the two parents are not known in the association because one of them has been overlooked. Some time since I suggested that a certain *Carex* which a collector sent me was a hybrid, but the collector denied it because one of the supposed parents had never been detected anywhere near his locality. I predicted that it would be found. The next year it turned up close at hand.

6. Rarity of the suspected individuals should be considered to indicate generally hybrid origin if the related species are common.

7. Localness and absence of "range" are most excellent suggestions of hybridity, particularly when the related species have well marked ranges. In other words, hybrids are generally accidental and spasmodic. Examples of my conception may be taken from the native apples and plums. My *Pyrus Soulandi* has a most disjointed distribution, whilst *Pyrus Ioensis* and *P. Malus* have continuous ranges in the same geographical region. My *Prunus hortulana* is similarly dismembered in distribution, whilst

Prunus Americana and *P. angustifolia* have good ranges. These facts first led me to suppose a hybrid origin for *Pyrus Soulandi* and *Prunus hortulana*, a conviction which is reinforced by other evidence, as I expect to publish shortly in detail.

My contention, therefore, is that since we agree that the species is not, as a matter of fact, an entity, we must abandon the conceptions of it which define it upon intrinsic characters; and we must look upon it as a more or less arbitrary division which it is expedient to use in taxonomy and nomenclature.

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